

FOREWORD

During the past twenty-four months and more, the former All India Council for Secondary Education and the present Directorate of Extension Programmes have been engaged in a long-range and countrywide programme of examination reform at the secondary school level. This reform is essentially one of a new approach to the problem of evaluation and testing of pupils in secondary schools. It seeks to emphasize the fundamental educational truth that in good education the objectives, methods of teaching and techniques of testing must reach the closest degree of integration.

Perhaps the foremost and most important task in any reform of this magnitude is to get the new idea disseminated to the vast population of teachers in the country. The officers of the central examination unit working in the Directorate have during these months tackled this problem of orientating teachers to the new concept of evaluation in several ways, through workshops, conferences, personal guidance to teachers, associations and Boards and through publications of various kinds. During the last Conference of the Secretaries of Boards that was held in September, 1959, the urgency of spreading the underlying principles of sound educational evaluation over a wider field of teachers and teacher educators in as short a time as possible through parallel measures was emphasised. As a result, the Directorate decided to bring out brochures explaining the concept and technique of evaluation in general and with regard to each of the subjects in which the Unit has been working during the past two years and make these brochures available to teachers and Boards.

The present brochure deals with evaluation in General Science. This subject has been recently introduced in our secondary school curriculum. General Science as distinct from the traditional subject of science comprising physics, chemistry and biology etc., has its own peculiar significance which is of great educative value to the secondary school pupil. This brochure seeks to clarify in simple terms the implications of General Science, the specific purposes of its teaching, the learning experiences that are required and the evaluation procedures suited to the two objectives taken for consideration, namely, knowledge and its application. The brochure is in no way complete in itself but if it succeeds in stimulating the teacher of

(ii)

General Science to think clearly about objectives in teaching the subject, to re-orientate his methods of teaching to suit these objectives and to devise testing procedures which would evaluate those objectives, it would have served its purpose.

We should be glad to receive from teachers, lecturers from Training Colleges and others interested in examination reform, their comments on the presentation given in the brochure and their suggestions for improvement with a view to increasing its utility.

NEW DELHI
March 30, 1960

(MISS) S. PANANDIKAR
Director
Directorate of Extension Programmes
for Secondary Education

CONTENTS

	Page
I. Introduction	1
II. Objectives of Teaching General Science	4
III. Developing Learning Experiences .. .	10
IV. Developing Test Material	24
V Planning for a Full Test	42
VI. Further Suggestions to Teachers	53
VII. Appendix	56
VIII. Bibliography	63

CHAPTER I—INTRODUCTION

The Purpose of the Brochure

This brochure has been prepared with the specific purpose of helping the practising teacher of General Science to effect certain reforms in the present system of examination in the subject. It may also prove useful to the paper-setters in external examinations.

As reform in examination envisages corresponding changes in the teaching and learning procedures, a discussion on the development of effective learning experiences has also been given a place herein.

The Present System

The present system of examination in General Science suffers from certain faults and defects, which also affect science education, the more so by the undue prestige attached particularly to external examination results. Some major defects are enumerated below :

- (i) Most of the questions set give importance to memory not to thinking, consequently, education stresses mere gathering and reproduction of information.
- (ii) Questions are often vaguely worded, giving room to wide variation in both answering and assessment. Questions like "Write short notes on.....," "Describe.....," "Discuss." "What do you know about. ?" are examples. How short a note should be, or, in describing and discussing, what to include and what to omit are left undefined.
- (iii) Without taking into account the abilities and skills developed during a course of study, the same kind of questions are repeated year after year. This has created a gap between teaching and testing, detracting from the validity of the latter.
- (iv) A question paper consisting of a few big questions, fails to give a fair representation to the entire course-content. Consequently, the evidence of pupil achievement thus obtained is not valid and reliable.

- (v) Lack of reliability creates tension and frustration in the students. They come to depend on luck rather than effort and ability. Harmful productions like guess-papers, bazaar notes, and coaching classes have come into vogue.

On account of these and such other short-comings, the present system of examination has lost its prediction value. It does not give any reliable guidance in raising the standards of teaching and learning. Eventually the whole system of education, which is examination ridden, has become stale and static.

In regard to certain other defects, a beginning seems to have been made towards their solution. For instance, instead of attaching sole importance to the annual examination, through-the-year records and periodic tests are being given weightage in many schools. The introduction of "internal assessment" is a welcome move in certain states like West Bengal and Madhya Pradesh. General Science is a subject of home assessment and not of external examination. Many schools have also started holding practical examinations in the subject. While all this is commendable, the fundamental defects enumerated previously are yet to be eliminated.

For this purpose an evaluation approach is suggested in the following pages, which not only attempts to solve problems in examination but also to refine and raise the teaching techniques and learning procedures.

The Evaluation Approach

This approach is based on the fact that the educational process consists of purposeful action, which brings about in the pupil desirable changes when appropriate learning experiences are provided to them. It also envisages a continuous appraisal of the purposes as well as the procedures of teaching and learning with a view to continuous improvement so that education becomes dynamic and self-developing. Thus, the evaluation approach consists of the following broad stages :

1. Formulating and selecting worthwhile objectives of teaching in a subject (in the present case General Science), and defining each objective in terms of expected learning outcomes which produce behavioural changes in the pupils ,
2. Developing appropriate learning experiences, which when provided to pupils through suitable course content, activities, aids and teaching devices, result in the realization of expected learning outcomes ,

3. Devising and adopting suitable assessment procedures to collect adequate and trust-worthy evidences about pupil achievements ,
4. Evaluating the outcomes on the basis of the evidences collected, and modifying the necessary aspects of the entire system for better results.

Thus, the evaluation approach aims at the establishment of close inter-dependence between educational objectives, learning experiences and continuous evaluation so that each may modify itself and grow in correspondence with the rest.

It also provides opportunities for a teacher to evaluate his work in the light of objectives at every stage. Before teaching a particular unit, he is in a position to validate the procedure he will adopt and the means he will use for providing suitable experiences to the pupils so that desired learning may result. After finishing the unit he is also in a position to appraise his efforts, using the same measuring rod of educational objectives, so that he can make a more efficient planning for the next unit. Such an auto-evaluation on the part of the teacher will make his efforts pointed and meaningful.

We shall now try to expand the above-mentioned stages of the evaluation approach to explain how this approach is helpful in planning better teaching as well as better evaluation.

CHAPTER II--OBJECTIVES OF TEACHING GENERAL SCIENCE

The first step towards the implementation of the evaluation approach is to formulate the specific objectives of teaching General Science. However, since objectives are related to the nature of the subject let us first consider the characteristic features of General Science.

The Concept of General Science

General Science, as a subject, provides general education in science to every individual irrespective of his special aptitudes. Science and its applications permeate modern life so extensively that every citizen has to have a knowledge of science for efficient living. General Science can, therefore, be defined as *everyday science for everybody*. From this definition flow corollaries some of which are stated below :

- (1) The study of the subject should provide such scientific knowledge, skills and qualities as every educated person must possess for efficient functioning in society.
- (2) Therefore its course-content should emerge out of the pupil's environment—both natural and social.
- (3) The content is best stated in terms of life situations, which will correlate and integrate various aspects of science. To illustrate, instead of talking in terms of light or heat or allotropy or metallurgy, the content may be stated in terms of units and problems confronted in daily life, such as, 'how do we get our drinking water' or 'plants that prepare food for us'.
- (4) In view of the utilitarian value of General Science, the knowledge and abilities acquired in it will have to be functional in relation to the pupil's daily life. Hence, its curriculum should be up-to-date and dynamic, and have a local colour. That is to say, the curriculum (which includes the objectives of teaching also) should be flexible enough to leave sufficient scope for incorporating changes that take place in the social as well as natural environment of the pupils from time

to time and place to place. Thus, General Science can be aptly termed as functional science.

The concept of General Science can be further clarified by stating what it is not. It is not a scientist's science. Even though its study serves as a good foundation for further scientific pursuits, its main function is to serve the needs of the 'common man'. Moreover, simply adding a branch or two like Biology or Astronomy to the existing syllabi with Physics and Chemistry does not make for General Science. The teaching of General Science being a matter of approach, it is incumbent upon the educators to frame the syllabus afresh with the definite purpose of imparting general education in science. Lastly, General Science may not be treated as synonymous with Elementary Science. While making the treatment of the subject more popular and less technical, it should not remain just elementary since it has to be functional and hence up-to-date. In fact, its scope and content would depend on the degree of complexity in the concerned society and the amount of science its people have absorbed in their daily living. With the increasing industrialization in India, and the urbanization of its villages, the quantum of General Science is bound to become more and more complex, hence the subject should not be taken or termed as Elementary Science.

Formulation of Objectives

A judicious formulation and selection of worthwhile objectives of any school subject goes a long way in enriching and sharpening both the teaching and the testing in that subject. Such objectives should be evolved in relation to the needs of the individual in his society.

The three main sources for the formulation of objectives are (i) the needs and capabilities of the Pupil, (ii) the specific demands of his social environment, and (iii) the nature of the subject-matter.

The foregoing discussion on the concept of General Science takes into account these three sources, namely, the child, the society, and the characteristics of the subject matter. It should, therefore, provide sufficient guide light for the formulation of objectives in the subject. Objectives thus formulated may be selected and classified in accordance with the psychology of learning, the principles of education and philosophy of life.

The objectives should be laid down in unambiguous and specific terms. Overall goals like developing the child into an

efficient citizen are too general and vague. Again since these objectives are formulated for the pupil, they should be stated in terms of the pupil, so that learning rather than teaching gets due emphasis. Every statement of objective should also describe the kind of change or growth expected in the child when the objective is realized, besides denoting the content through which the change is to be brought about. Let us take, for instance, this objective. To develop skill in handling apparatus, instruments and appliances. Here, 'to develop skill' describes the growth or the change desired in the pupil, while the latter part of the objective refers to the content, namely simple laboratory for performing certain experiments, and instruments and appliances such as thermometer, barometer pumps, and syphon.

To illustrate the points developed above, some objectives of teaching General Science are listed below. The list is not to be treated as exhaustive.

Illustrative List of Objectives

1. The pupils studying General Science should acquire knowledge of the fundamentals of science useful to all in everyday life.
2. They should develop the ability to apply the knowledge in everyday life.
3. They should acquire experimental skills such as
 - (a) handling apparatus and instruments ;
 - (b) arranging apparatus for an experiment ,
 - (c) preserving apparatus, chemicals, specimens, models, etc.
4. They should acquire constructional skills such as :
 - (a) improvising simple instruments and appliances ;
 - (b) repairing certain instruments and appliances of everyday use.
5. They should develop drawing skills such as :
 - (a) drawing and sketching certain objects, instruments and arrangements ,
 - (b) photographing certain objects and specimens.
6. They should be able to locate reliable and recent information from appropriate sources.

7. They should be able to interpret scientific data given in various forms such as tabular, graphical, descriptive, etc
8. They should develop the power of minute observation of surroundings.
9. They should develop the power of oral expression in science, that is to say, they should be able to discuss, argue, describe and raise questions, using scientific terminology.
10. They should develop the scientific method in thinking and action.
11. They should adopt the scientific attitude in making statements, accepting information and forming beliefs.
12. They should develop interest in scientific reading and hobbies.
13. They should be able to appreciate the impact of science on life, both personal and social, the struggle through which science has advanced and the inspiring work of scientists.

It is suggested that every teacher should formulate and finalize a set of worthwhile objectives of teaching General Science, keeping in view its concept, the age and ability of his pupils, the beliefs, customs and traditions of his community, the scientific level of his society, its immediate and remote needs, the psychology of learning, the principles of education, and any other relevant factors.

Clarification of Objectives

In order to make objectives effective guides to develop (i) learning experiences and (ii) evaluation procedures, each objective may be further clarified and its scope defined in terms of specific learning outcomes or behaviour changes. For example, a pupil may be passed in respect of knowledge about building materials such as mortar, cement and concrete, when he is able to recognize them and distinguish between them in their properties, uses, etc. and to select the right material for a given purpose. Similarly, a pupil may be passed in respect of ability to apply knowledge if he can, say, explain why certain fruits putrify sooner than others, but remain fresh in a refrigerator, or if he can predict as to what would happen if an

electrical appliance working on 110 volts is inserted in a 220 volt circuit.

Thus, realization of each objective will result in certain competencies in the pupil, which in turn will develop new behaviour patterns. This is the reason why learning outcomes are stated in terms of pupil behaviours, which indeed are the end-products of education

By way of illustration, two basic objectives of teaching general science and their specification in terms of pupil behaviour are given below :

1. *Objective*—To acquire knowledge of the fundamentals of science useful to all in everyday life.

Specifications of the objective in terms of pupil-behaviours :

The pupil who has acquired such knowledge

- (i) recognizes certain terms, facts, principles, objects, specimens, instruments, appliances, etc.,
- (ii) recognizes the distinction between closely related substances, instruments, terms and concepts, principles, etc.,
- (iii) detects errors or defects in certain instruments, experimental procedures, etc., and suggests rectification
- (iv) cites examples of certain facts, principles, processes, properties, etc.,
- (v) makes simple calculations based on certain scientific relationships.

2. *Objective*—To develop the ability to apply the acquired knowledge in every day life.

Specifications in terms of behaviour changes : The pupil who has acquired the ability specified in the second objective

- (i) explains scientific phenomena, giving reasons,
- (ii) makes predictions,
- (ii) selects appropriate means to accomplish a given purpose;
- (iv) suggests plans for an experiment ;

(v) makes plans for improving certain instruments and appliances.

(It may be noted that the situations provided to pupils for application during teaching as well as testing, should be new and unfamiliar to them).

We shall now discuss the teaching and learning procedures to be developed in accordance with the objectives formulated and specified as above.

CHAPTER III—DEVELOPING LEARNING EXPERIENCES

Concept of Learning Experience

A clearly defined objective has two dimensions, the behavioural aspect and the content aspect. The student learns the content (of a syllabus) to attain the behaviour. How does a student learn ? Essentially, learning takes place by interaction between the content and the learner. It is what he does that he learns, and not what the teacher does. This doing by the learner, or interaction between content and learner, results in learning. And it is such learning experiences that link content with behaviour. Such learning experience is therefore bipolar. It acts and reacts. It springs from content and grows towards behaviour. It emerges from behaviour in relation to content.

From the above explanation it is seen that learning experience is not a part of a syllabus, nor is it a unit, nor is it a traditional lesson plan, nor mere activity. Learning experience is the interaction of the content of the syllabus and the learner. As a result of this interaction, learning results in a particular behaviour of the learner in relation to the content.

How to Develop Learning Experiences

There are two methods of developing learning experiences namely, (i) the contrast method and (ii) the identification method.

(i) The Contrast Method

The teacher imagines two students—one who has understood the content of the syllabus and the other who has not. He notes down differences in their behaviours in relation to the syllabus content. The kind of differences would suggest the learning experiences to be provided.

(ii) The Identification Method

The teacher puts himself in the position of the student who has understood the content of the syllabus and notes down

the various behaviours of the student in relation to the syllabus content. These behaviours would suggest learning experiences.

Learning Experiences in the Classroom and Outside

Learning experiences are not merely confined to the classroom. They can be developed outside also and should complement each other.

Learning Experiences Through Teaching Devices

(i) *Experiments*—Experiments provide learning experiences to develop objectives such as skill in designing, experimentation, skill in handling apparatus, skill in observation understanding etc.

(ii) *Audio-visual aids*—Radio, films, filmstrips, epidiascope etc., enrich teaching and stimulate pupil interest. Their appeal provides learning experiences which widen the scope of understanding and develop interest in the subject.

(iii) *Trips*—They provide learning experiences to develop power of observation, ability to collect data, etc.

(iv) *Science Clubs*—They provide experiences which would develop scientific interest and the ability to apply science to life situations, foster further scientific knowledge and strengthen the ability developed by experiments.

(v) *Science Literature and the School Library*—The school science library provides learning experiences in developing abilities in (a) locating information by the use of index, table of contents, map reading and skimming, (b) interpreting what is read by finding answers to questions, interpreting graphs and charts and selecting pertinent items of information, and (c) organising and evaluating by finding key sentences in paragraphs, finding the main thought of a paragraph, making notes, summarizing and making outlines.

The library activities can be geared to the development of problem-solving skills which entail locating information, evaluating authorities, arriving at tentative conclusions and thinking independently.

Teacher-pupil Planning for Developing Learning Experiences

The teacher must be very clear in his mind as to why he is teaching and what he is teaching. The first refers to objecti-

ves and the second refers to the course content. This is done in General Science by stating a problem in relation to the objective. Students learn problem-solving techniques by actually solving problems which are both interesting and worthwhile. They should therefore share in setting problems from a given situation in the field of General Science and in planning their solutions. The setting of a problem, however, should be planned carefully by the science teacher. A co-operative approach is necessary, in which the teacher opens the field for investigation, draws out experiences of pupils which suggest places where problems might exist, and then encourages them to state the problem in their own words.

The teacher should keep in mind that a good problem should be

- (i) at the maturity level of the pupil,
- (ii) clearly defined ;
- (iii) possible of solution with materials at hand ;
- (iv) broad enough to provide variation of activities in its solution;
- (v) a part of enlarged understanding; and
- (vi) worthwhile for the learner.

Learning Experiences in Daily Teaching

Learning experiences in teaching are invariably related to a number of predetermined objectives. It is not generally practicable nor desirable to aim at only one objective or one behaviour. Usually it is found necessary to bring in other objectives also. For instance in General Science, although we select two main objectives (acquiring knowledge and applying it in life), we have often to deal with other objectives like, skills in handling apparatus, solving problems, designing experiments, scientific methods, attitudes, etc.. Accordingly, learning experiences have to be developed in relation to these objectives also. In other words, while we are aiming mainly at the attainment of one objective, we are partially attaining other objectives also at the same time.

Learning Experiences in General Science

The syllabus in General Science should be framed in units (vide syllabus in General Science in the Draft Syllabus for Higher Secondary Schools, 1957, p. 22), such as "Our surroundings", "Nature of things", and "The human machine—its

needs and care" These units are to be developed in relation to objectives, through learning experiences. The development may cover one, two or several periods, depending on the nature of the unit and the problem involved.

An Illustration

In the following illustration, the unit "Weather" is broken down into sub-units. From these sub-units learning experiences are developed (and separately listed), such as would evoke specified behaviours implied in the two objectives, knowledge and application. Evaluation items based on these sub-units and behaviours, are constructed and listed in the appendix. These would show how far the objectives have been attained.

ILLUSTRATIVE UNIT—"WEATHER",

- Objective . (1) To acquire knowledge of "Weather",
(2) To apply the knowledge of weather in everyday life.

- Problems . (1) What determines weather ?
(2) How do we forecast weather ?

CONTENT OF THE UNIT

Our life depends on the atmosphere surrounding the earth. The constant changes in the atmosphere have great effect on our lives. How do these changes come about in the atmosphere? How can we account for the different kinds of weather ?

- (1) Factors that bring about changes in atmosphere :
(a) Temperature of the atmosphere and moisture in the air,
(b) Air pressure,
(c) Wind.

- (2) Weather forecast .
(a) Instruments used to predict weather,
(i) Barometer
(ii) Maximum and Minimum thermometer,
(iii) Wet and dry bulb thermometer,
(b) Study of weather charts.

Problem (I) is dealt with in the following table as an illustration.

Objective 1—To acquire knowledge of weather

Sub-unit	Behaviour	Learning Experience	Remarks
1	2	3	4
I. Factors that determine weather mainly depend on	The student (1) collects data with a purpose, (2) recognises scientific terms.	The student (1) Discusses such terms as cloudy weather, fine weather, stormy weather, humid weather, sultry weather. (2) Collects weather reports from newspapers (3) Reads and locates words which are pointers of weather, such as "rainfall in mm", "maximum and minimum temperature", "sunrise and sunset", storm, "low pressure moving in a particular direction", "dry and moist air". (4) Discusses the meaning of these pointer words and how they affect weather e.g. how does the time of sunrise and sunset help us to know the factors that affect weather? What is meant by "Low pressure moving in a particular direction"? Why does it move?	The teacher initiates discussion on factors that determine weather. What is cloudy weather, sultry weather, fine weather etc.
(a) Temperature of the atmosphere and moisture in the air.			<i>Specimen of weather report</i> New Delhi, October, 13 1959 Yesterday's well marked low pressure persists over Saurashtra. It is likely to move North-East. Monsoon has withdrawn from South Punjab. Weather over North-West U.P. is dry. Forecast valid until tomorrow evening. Rainfall will be low in South East Rajasthan. The weather will be dry. Station Max 36°C Min 21°C New Delhi 36°C 21°C Rainfall since 1st October—27 mm Relative humidity at 5-30 P.M. was 33 per cent
(b) Air Pressure			Time at sunrise 6-20 A.M. Time at sunset 5-30 P.M.
(c) Wind	Student generalises into broad categories.	The student (1) relates pointer words with factors determining weather and formulates factors into broad categories (2) finds out factors determining weather	The teacher helps to find out factors from pointer words and writes them on the black-board.

<p>I(a) Heating of atmosphere: How is atmosphere heated? More by radiation from the earth than by direct rays of the sun.</p>	<p>The student recognises scientific processes</p>	<p>The student</p> <ol style="list-style-type: none"> (1) listens actively to teacher's explanation of the heating of atmosphere. (2) draws diagram of how the atmosphere is more heated by radiation from the earth than by direct rays of the sun. 	<p>Teacher explains by diagram. Students do the experiment in groups. They suggest another experiment to show how hot air rises—This is the behaviour in "application objective".</p>
<p>I(a)-1 Rising of warm air . .</p>	<p>The student observes and draws inference</p>	<p>The student</p> <p>observes teacher's demonstration—experiment showing how smoke rises up from a burning paper held over a burning candle placed in a box with two holes at its top WHY?</p> <p>The student</p> <ol style="list-style-type: none"> (1) finds causes and effects due to unequal heating of atmosphere and earth by radiation from the situations in column I(a)-2. (2) taps sources of information from textbooks and reference books on General Science. (3) discusses in groups all the situations. 	<p>Teacher initiates the discussion by placing before the class the situations in column I(a)-2.</p>
<p>I(a)-2 Unequal heating of atmosphere by radiation. (a) causes. (b) effects . . Situations . How is radiation affected by (i) long hours of day light (ii) presence of clouds, smoke and dust in air (iii) slanting rays of the sun in the morning and evening.</p>	<p>The student explains the cause-effect relationship.</p>	<p>The student</p> <ol style="list-style-type: none"> (1) observes teacher's demonstration experiment (for situation iv) (2) writes down the procedure and aim, apparatus and material, method, observations and conclusions. 	<p>Students suggest another experiment—Do materials warm and cool at the same rate? (This is the behaviour under application).</p> <p>Teacher explains how to write down the experiment.</p>

Objective 1—To acquire knowledge of weather

Sub-unit	Behaviour	Learning Experience	Remarks
1	2	3	4
I. Factors that determine weather mainly depend on	The student (1) collects data with a purpose, (2) recognises scientific terms.	The student (1) Discusses such terms as cloudy weather, fine weather, stormy weather, humid weather, sultry weather. (2) Collects weather reports from newspapers. (3) Reads and locates words which are pointers of weather, such as "rainfall in mm", "maximum and minimum temperature", "sunrise and sunset", storm, "low pressure moving in a particular direction", "dry and moist air". (4) Discusses the meaning of these pointer words and how they affect weather e.g. how does the time of sunrise and sunset help us to know the factors that affect weather? What is meant by "Low pressure moving in a particular direction"? Why does it move?	The teacher initiates discussion on factors that determine weather. What is cloudy weather, sultry weather, fine weather etc
(a) Temperature of the atmosphere and moisture in the air.			<i>Specimen of weather report</i> New Delhi, October, 13, 1959 Yesterday's well marked low pressure persists over Saurashtra. It is likely to move North-East. Monsoon has withdrawn from South Punjab. Weather over North-West U.P. is dry. Forecast valid until tomorrow evening Rainfall will be low in South East Rajasthan. The weather will be dry Station Max 36°C Min 21°C New Delhi Rainfall since 1st October—27 mm. Relative humidity at 5-30 P.M. was 33 per cent
(b) Air Pressure			Time at sunrise 6-20 A.M. Time at sunset 5-30 P.M.
(c) Wind	Student generalises into broad categories.	The student (1) relates pointer words with factors determining weather and formulates factors into broad categories (2) finds out factors determining weather.	The teacher helps to find out factors from pointer words and writes them on the black-board

Teacher? explains by diagram. Students do the experiment in groups. They suggest another experiment to show how hot air rises—This is the behaviour in "application objective".

Teacher initiates the discussion by placing before the class the situations in column 1(a)-2

Students suggest another experiment—Do materials warm and cool at the same rate? (This is the behaviour under application)

Teacher explains how to write down the experiment.

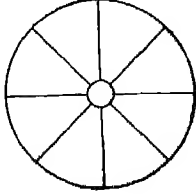
<p>1(a) Heating of atmosphere: How is atmosphere heated? More by radiation from the earth than by direct rays of the sun.</p>	<p>The student recognises scientific processes</p>	<p>The student</p> <ol style="list-style-type: none"> (1) listens actively to teacher's explanation of the heating of atmosphere. (2) draws diagram of how the atmosphere is more heated by radiation from the earth than by direct rays of the sun. 	<p>Teacher? explains by diagram. Students do the experiment in groups. They suggest another experiment to show how hot air rises—This is the behaviour in "application objective".</p>
<p>1(a)-1 Rising of warm air . .</p>	<p>The student observes and draws inference.</p>	<p>The student</p> <p>observes teacher's demonstration—experiment showing how smoke rises up from a burning paper held over a burning candle placed in a box with two holes at its top WHY?</p> <p>The student</p> <ol style="list-style-type: none"> (1) finds causes and effects due to unequal heating of atmosphere and earth by radiation from the situations in column 1(a)-2. (2) taps sources of information from textbooks and reference books on General Science (3) discusses in groups all the situations. 	<p>Teacher initiates the discussion by placing before the class the situations in column 1(a)-2</p>
<p>1(a)-2 Unequal heating of atmosphere by radiation.</p> <p>(a) causes.</p> <p>(b) effects . .</p> <p>Situations :</p> <p>How is radiation affected by</p> <ol style="list-style-type: none"> (i) long hours of day light (ii) presence of clouds, smoke and dust in air (iii) slanting rays of the sun in the morning and evening. 	<p>The student explain the cause-effect relationship.</p>	<p>The student</p> <ol style="list-style-type: none"> (1) observes teacher's demonstration experiment (for situation iv) (2) writes down the procedure and aim, apparatus and material, method, observations and conclusions. 	<p>Students suggest another experiment—Do materials warm and cool at the same rate? (This is the behaviour under application)</p>

1	2	3	4
<p>(iv) soils and rocks—dark coloured surfaces light-coloured surfaces</p> <p>(v) water surfaces vs. land surfaces,</p>	<p>The student</p> <p>(i) knows the sequence of a scientific process ;</p> <p>(ii) tests the adequacy of data.</p>	<p>The student</p> <p>(1) discusses in groups the questions in column 1-(a)-3 and finds out the sequence ,</p> <p>(2) suggests (a) indirect proof that air contains water vapour (b) circumstances in which water vapour condenses ,</p> <p>(3) suggests apparatus for determination of dew-point ,</p> <p>(4) observes teacher demonstration of the experiment for determining dew-point ,</p> <p>(5) does practical work in groups for determining dew-point and writes the experiment ;</p> <p>(6) listens actively to teacher's explanation of formation of cloud, fog and rain</p>	<p>Teacher initiates discussion and writes on black board questions in a particular order</p> <p>Teacher helps students in recording in their note books</p>
<p>1(a)-3 Condensation of water</p> <p>(i) How to prove that air contains water vapour ?</p> <p>(ii) When does water vapour in air condense? When will it condense into droplets ?</p> <p>(iii) What is dew-point ?</p> <p>(iv) How is dew-point found ?</p> <p>(v) What happens to water vapour when the dew-point is reached ?</p>			

<p>I-(a)-4 Formation of</p> <p>(i) fog, dew, frost,</p> <p>(ii) clouds, rain and snow</p> <p>(iii) hail.</p>	<p>The student compares and contrasts scientific processes and conditions</p>	<p>The student</p> <p>(1) taps sources to collect information from relevant portions in books on General Science, using index, table of contents etc.</p> <p>(2) discusses in groups the conditions under which fog, dew, frost, rain etc are formed</p> <p>(3) interprets what is read by putting down conditions of formation of fog, dew etc. ;</p> <p>(4) selects pertinent items of information ;</p> <p>(5) listens to teacher's explanation</p>	<p>Teacher initiate as discussion on different forms of condensation of water vapour in air</p>
<p>I-(b)-1 Air Pressure .</p> <p>Prove that</p> <p>(i) air has weight ;</p> <p>(ii) air exerts pressure,</p>	<p>The student recalls and recognises scientific procedures</p>	<p>The student describes the already known experiments to prove that air has weight and exerts pressure</p>	<p>Teacher asks questions on previous knowledge of the students. The students suggest different experiments not already demonstrated in the class This behaviour comes under ' application objective '</p>
<p>I-(b)-2 Cool air at high altitudes: Why is air at mountain tops cooler than on the plains ?</p>	<p>Student explains cause-effect relationship.</p>	<p>The student discusses heating effect of radiation at different distances from the surface of radiation.</p>	<p>Students suggest an experiment. This behaviour comes under "application objective."</p>

1	2	3	4
<p>L(b)-3 Effect of heat on air pressure.</p>	<p>The student explains relationship.</p>	<p>The student (1) discusses heating effect on air ; effect (2) suggests illustrations of heating on air e.g bursting of inflated tyres in summer ; (3) suggests experiments to show the effect of heating air on its pressure.</p>	
<p>I(c) Winds</p>	<p>The student (1) recalls and (2) explains cause-effect relationship.</p>	<p>The student explains phenomenon of land and sea breezes by reference to books on General Science and in Geography.</p>	
<p>I(c)-1 Law of wind How wind blows</p>	<p>The student draws generalizations.</p>	<p>The student (1) refers to weather reports in newspapers already collected . (2) notes down areas of high and low pressure (3) observes from the reports how these areas move , (4) draws diagrams of the movement of high and low pressure areas , (5) finds out the direction of winds.</p>	<p>Teacher places before the class various areas of high and low pressure.</p>
<p>I(c)-2 Circulation of atmosphere (1) Why does air at the equator tend to rise</p>	<p>The student explains cause-effect relationship</p>	<p>The student (1) taps sources to collect relevant information from geography and science books. (2) listens to teachers' explanation , (3) draws diagrams showing the circulation of atmosphere on the surface</p>	<p>Teacher explains by diagram how winds blow towards the equator</p>

Objective 2—To apply the knowledge of weather in every day life
Unit : Weather.

Sub Unit	Behaviour	Learning experience	Remarks
1	2	3	4
<p>I (a) Heating of atmosphere</p> <p>b) —1 Rising of warm air.</p>	<p>The student</p> <p>(a) suggests new devices;</p> <p>(b) constructs new instruments and appliances.</p>	<p>The student designs experiments to show the effects of the rising of warm air.</p> <p>(i) Construction of a paper spiral.</p> <p>(a) Cut from a sheet of paper, a disc about 3" in diameter.</p> <p>(b) Draw a spiral on it 1/4" wide.</p> <p>(c) Cut the spiral out of the paper sheet</p> <p>(d) Suspend over a burning candle.</p> <p>(e) Observe the movement of spiral.</p> <p>(ii) Construction of a paper pin wheel</p> <p>(a) Draw the figure on a paper as follows.</p>	<p>Teacher initiates the discussion :—</p> <p>You already know that air rises as it is being warmed, but air is invisible. It can not be seen moving upwards as it is warmed. There are interesting ways of observing the effects of air moving upwards. What are they ?</p> <p>Design some experiments</p>
			
		<p>(b) Cut along each of the eight lines from the edge of the disc to the inner circle. Bend each section to form a pin-wheel (like an electric fan of 8 blades).</p>	

1	2	3	3
<p>1 (a)—Unequal heating of atmosphere by radiation.</p> <p><i>Situation</i> How is radiation effected by different materials?</p> <p>Do materials warm and cool at the same rate? Take sand, soil and water as materials.</p>	<p>The student</p> <p>(a) predicts and checks the prediction,</p> <p>(b) suggests new procedures;</p> <p>(c) compares and contrasts scientific facts</p>	<p>(c) Suspend the pin wheel over a burning candle by running a pin through the centre and attaching it to a string.</p> <p>(d) Observe the movement of the pin wheel. The students now interpret their observations in (i) and (ii) as below:</p> <p>(i) Why is the paper spiral and the paper wheel suspended over a burning candle or some source of heat?</p> <p>(ii) What is the proof that warm air rises?</p> <p>The student</p> <p>(1) finds out by experiment which of the three substances—sand, water or soil—warms most quickly and cools most rapidly</p> <p>(a) What is the specific heat of water?</p> <p>How does it compare with that of sand or soil?</p> <p>(b) What is your prediction about the rate of warming and cooling of water?</p> <p>(2) Place equal amounts (weights) of water, sand and soil in three separate beakers. Place a thermometer in the contents of each beaker. Place the three beakers in the sun-shine near each other and record the temperature every 10 minutes for half an hour. Then place the beakers in the shade and take the temperatures every 10 minutes for half an hour</p>	<p>Teacher raises a problem—Do materials warm and cool at the same rate? (The behaviour—to compare and contrast—is implied in the knowledge objective but it is also implied by Application objective. This means that there is overlapping of behaviours in the hierarchy of educational objectives).</p>

I(a)-3 Conduction of water	The student (a) collects information with a purpose, (b) identifies a principle in a problem situation and finds its relationship with the data supplied in the problem.	<p><i>Interpretation :</i></p> <ol style="list-style-type: none"> (1) Which material warms most quickly? (2) Which material cools most quickly? (3) Compare and check each other's results their earlier predictions (i.e. Check the experiment was performed).
(1) Explain the formation of thunder storm (i) lightning (ii) lightning		The student (1) taps relevant sources and reference books on General Science ;
(2) How are clouds electrically charged?		(2) collects information relevant to the formation of thunderstorm and electrical charging of clouds ,
(3) Determination of dew-points. How cold must a polished metal surface be before water vapour from air condenses upon it?	The student formulates a hypothesis and checks it.	(3) draws diagrams to show how static electric charges are built upon clouds and how lightning is formed.
		<p>The student suggests</p> <ol style="list-style-type: none"> (1) what he needs for doing the experiment; (2) what procedure he follows; (3) basic assumptions in the experiment; (4) whether the temperature of condensation of water—vapour is different on different days; (5) whether the temperature is different at different places on the same day ; (6) whether the temperatures registered on mountain tops and on plains are different on the same day.

1	2	3	4															
<p>(b)-1 Air pressure</p> <p>I(b)-2 Cool air at high altitudes. Why is air on mountain tops cooler than on plains?</p>	<p>The student uses new (unfamiliar) methods in the place of familiar ones.</p>	<p>The student suggests (1) various evidences that air has weight and exerts pressure, (2) methods to find out (a) weight of air in a classroom, (b) pressure of air per square inch, (given that air has a weight of 0.08 pounds per cubic foot at an average height of 26,460 ft above sea level). (3) suggests and performs the experiment on the heating effect of radiation at different distances from the radiating surface. On a day when the sun is brightly shining, the temperature of air is recorded at different distances from the side of the building against which the sun is shining.</p> <p>(4) Records the results in the table below :</p> <table border="1"> <thead> <tr> <th>Readings</th><th>Distance</th><th>Temperature</th></tr> </thead> <tbody> <tr> <td>a</td><td>1'</td><td></td></tr> <tr> <td>b</td><td>1'</td><td></td></tr> <tr> <td>c</td><td>5'</td><td></td></tr> <tr> <td>d</td><td>10'</td><td></td></tr> </tbody> </table>	Readings	Distance	Temperature	a	1'		b	1'		c	5'		d	10'		
Readings	Distance	Temperature																
a	1'																	
b	1'																	
c	5'																	
d	10'																	

Conclusion :

The student answers the following questions :

- (1) Which thermometer was nearest to the sun ?
 - (2) How does the sun's heat reach it ?
 - (3) How does this help to explain the cooler temperature on mountain tops
-

Specimen test items based on the two objectives on which the learning experiences have been developed are given in the Appendix at the end of the book

CHAPTER IV—DEVELOPING TEST MATERIAL

The main purpose of examination and assessment is to find out how far the efforts made in teaching and learning have become successful in achieving the objectives. Therefore, the third stage of evaluation approach is to develop test material in relation to the objectives of teaching. The material, when administered to pupils, should provide trust-worthy evidences as to whether the behaviour changes envisaged in pupils as a result of teaching have come about or not.

To construct pointed questions which test a given objective requires careful thought. Hitherto, we have kept only the topic in view while constructing question, with the result that the questions have been mainly of the information type which hardly evoked any higher mental processes. The new method of test construction seeks to link the particular objective or its specification with the topic so that the item is valid and thought-provoking.

Here again, the specific behavioural changes that are expected as learning outcomes under each objective are of great importance in establishing a close relationship between the test-item and the objective. They also direct our own thinking and facilitate the task of constructing good items.

Below are given a few specimens of test-items geared to a given behaviour under a specified objective.

SPECIMEN TEST-ITEMS

1. Knowledge Objective

- | | |
|---------------|---|
| 1. Behaviour: | The pupil recognizes terms, facts and principles. |
| Topic: | Living things. |
| Test-item: | Place a cross against the most appropriate answer in the space provided for it.
Every living being consists of
() A. one or more atoms
() B. one or more cells
() C. tissues. |

() D. various organs

() E. various systems

2. Behaviour. The pupil recognises the distinction between closely related terms, concepts, facts, processes, etc.

Topic: The universe around us.

Test-item: Out of the following underline the one which does not belong to our solar system.

- 1 Evening star
2. Shooting star
3. Pole star
4. Artificial satellite
5. Asteroid.

3. Behaviour. The pupil detects errors in certain instruments, experimental procedures etc. and suggests rectification.

Topic : The principle of Archimedes.

Test-item : A student performs an experiment to determine the specific gravity of a solid insoluble in water by the application of the principle of Archimedes. He weighs the solid in air and again in water. Then he calculates the specific gravity as equivalent to $\frac{\text{weight in water.}}{\text{weight in air}}$

Which of the following mistakes did the student commit ? Indicate your answer by putting a tick-mark in the space provided.
He did not

- () A find the weight of the solid in kerosene or other liquid
- () B. calculate the volume of the solid
- () C. divide the loss of weight in water by weight in air.

() D. divide the weight in air by the loss of weight in water

() E. find out the ratio weight in air/weight in water.

4. Behaviour : The pupil cites examples of certain facts, principles, processes, etc.

Topic The principle of Archimedes.

Test-item : Which one of the following statements corresponds to the Principle of Archimedes ? Indicate your answer by placing a tick-mark in the space provided.

() A. A country boat floats on water

() B A piece of iron sinks in water when dropped into it

() C. A stone seems to weigh less in water than in air

() D. Huge icebergs float on water

() E. A piece of iron does not sink in mercury.

5. Behaviour : The pupil makes simple calculations based on scientific relationships

Topic Electricity in daily life.

Test-item : What would be the monthly consumption of a 100 watt fan when run for 8 hours a day on the average, during the month of June, if the electric charges are 15 nP per unit?

Tick-mark your answer in the space provided.

() A. Rs 2 00

() B. Rs 2 40

() C. Rs. 4.80

() D. Rs. 6.00

() E. Rs. 8.00.

II. Application Objective

The mental process involved in the application of knowledge is comparatively more complex. The stages involved in the process may generally be stated as below :

- (i) Preliminary study and analysis of the problem.
- (ii) Recalling the relevant part of knowledge which seems to be applicable in a given situation.
- (iii) Finding implications and establishing relationships
- (iv) Drawing hypotheses
- (v) Verification and conclusion.

Below are listed a few illustrative test-items on various behaviours expected to be developed under this objective. Try to solve them with a view to analysing the mental processes involved

- | | |
|----------------|---|
| 1. Behaviour . | The pupil explains a scientific phenomenon giving reasons. |
| Topic . | The weather |
| Test-item | Place a tick-mark against the correct answer in the space provided.
Soon after rain in hot weather, we feel stuffy because |
- () A. air expands considerably due to the rise in temperature of the atmosphere
 - () B. the capacity of the atmosphere to hold water vapour increases due to rain
 - () C. the increase in temperature adds to the capacity of the atmosphere to hold more water vapour
 - () D. the rise in temperature makes the atmosphere hot which gives a sensation of stuffiness
 - () E. along with rain, the water vapour which had been in the atmosphere is turned to water and removed from the atmosphere, and hence the stuffiness.

2. Behaviour . The pupil makes predictions.
- Topic The solar system.
- Test-item . Tick off the correct answer in the space provided. An artificial planet is to be launched in space in such a way that its orbit falls between that of the Earth and Venus. The Sun from that planet would, therefore, look
- () A. bigger and brighter than it looks from the Earth
 - () B. smaller and brighter than it looks from Venus
 - () C. smaller and dimmer than it looks from the Earth
 - () D. the same in size but brighter than it looks from the Earth
 - () E. the same in size but dimmer than it looks from Venus.
3. Behaviour . The pupil selects appropriate means for a given purpose.
- Topic : Separation of mixtures.
- Test-item . In order to separate the components of a mixture of sand, common salt and iodine which of the following sets of apparatus is the most appropriate? Indicate your answer by a tick-mark in the space provided.
- () 1. Beakers, retort, flasks, spirit lamp, blotting paper, wiregauze and water
 - () 2. Crucible, funnel, filter paper blotting paper, spirit lamp, beakers, clay-pipe triangle, tripod and water
 - () 3. Hard glass test-tube, bar magnet, beakers, filter papers, blotting paper, funnel and water

- () 4 Filter papers, blotting paper, retort, flask, spirit lamp, tripod-
clay-pipe triangle and water
- 4 Behaviour The pupil suggests plans for an experiment
- Topic Electricity in daily use.
- Test-item After getting your table-fan repaired you want to find out its consumption of electricity in terms of watts. Narrate the experimental procedure you would adopt for finding out the consumption with the help of electrical appliances usually available in homes in which electricity is used.
5. Behaviour : The pupil makes plans for improving certain instruments and appliances.
- Topic : Hydrometry.
- Test item . Given only the following materials, narrate how you would improvise a hydrometer to detect adulteration in milk. Draw a diagram of your instrument as and when ready for use, labelling all the essential parts.
- Materials . A long narrow test tube, a water-tight cork fitting the test tube, ink, nails, paper, pure water and pure milk (density 1.2 gm/cc) in cylinders, string.

The foregoing test items try to illustrate how questions can be constructed on the basis of a given objective and its specification. This is the most important criterion of a good question. There are several other criteria, also which a test-framer has to bear in mind while framing good test-items.

CRITERIA OF A GOOD TEST-ITEM

The drawbacks observed in the present system of examination in General Science have been analysed earlier in this brochure. It has been pointed out that many of them lie in the question itself. Therefore, measures should be considered at this stage of improving questions by setting definite criteria which good questions should satisfy. They may be stated as follows :

1. Every question should be based on an objective or its specification (s)
2. It should promote thinking rather than rote-memorization.
3. It should be precisely worded so that the answer is pointed and definite.
4. It should be constructed in a suitable form (essay or objective)
5. It should sharply distinguish the brighter pupils from the weaker, and should have a desired difficulty value.

These criteria are explained below .

(1) The question should be related to an objective :

The criterion which represents the basic approach in evaluation has been profusely illustrated and discussed earlier and requires no further amplification here.

(2) The question should promote thinking rather than rote-memory :

The greatest harm done by the present examination system is its adverse effect on the study-habits of pupils. Many of the questions that are set encourage them in cramming and mechanical memorization. Consequently their ability to think is inhibited. But when questions are well-gearred to objectives such as application, interpretation and analysis, thinking will necessarily have to emerge. However the urgency for making our questions thought-provoking needs special mention vis-a-vis the traditional type of questions.

To illustrate the point, let us examine the following question .

What do you know about the anomalous expansion of water?

Or, as we sometimes put it,

Write a short note on the anomalous expansion of water.

Both these versions direct pupils to memorize some of the facts related to the topic, and evoke no worthwhile thinking.

Now the same situation may be altered a little and the same question may be so designed that pupils are required to think in order to answer it.

e.g., A certain amount of water is at 4°C . What will happen to its volume

- (a) if the temperature is increased ?
- (b) if it is decreased ?

Such a question would put greater premium on thinking while still testing the main understanding about anomalous expansion of water in a more sharp and pointed manner.

(3) *Precision in Wording :*

In order to avoid subjectivity in answering a question, and so in assessment, the wording of a question should be point-precise. We often come across question like : What is density ? What is specific heat ? and so on. Framed in this way, a question may bring a variety of different answers whose valuation will differ with different examiners. When a question was put to a conference of competent science teachers as to what answer was expected of pupils to the question, "Write a short note on the Electric Bell", the teachers unanimously agreed that a diagram should be drawn, but disagreed about labelling the diagram and writing its construction. Some felt that in a short note the construction need not be described if the diagram was labelled, and others affirmed that construction should be described but the diagram need not be labelled, while still others were of the opinion that both were essential, irrespective of the fact that the answer was to be a short note.

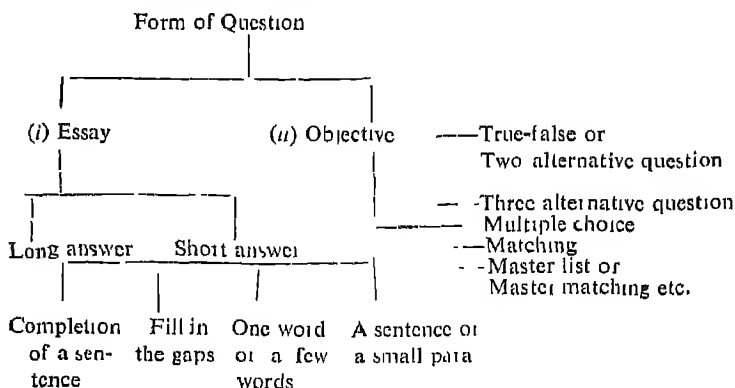
Such differences arise not only among teachers (who are also examiners), but among pupils who answer such questions. It is, therefore, essential to avoid vague or ambiguous words and phrases like Discuss....., Describe..... What do you know about ? Can you ? when employing the essay type of questions.

Such precision becomes all the more important in the case of objective type questions. This point will be further clarified while discussing the construction of objective forms of questions below.

(4) *Forms of Questions :*

Framing a good test-item is one of the essential criteria for bringing about improvement in our examinations. Selection of an appropriate form of a question is helpful in various respects

while improving the quality of questions. The different forms of questions may be shown as follows —



(i) The Essay Form of Question

A. Long-answer Question—This form of question usually known as “The essay type question” is very popular with us. It is specifically useful in testing skills like written expression and organisation of matter. Objectives like creative thinking, planning and imagining necessarily call for the long-answer question. Example of an essay type questions: Explain the formation of (a) fog and (b) dew in your locality.

It is generally believed that such questions are easier to construct. This may be true in respect of the ordinary information question, but an essay question need not always be an information question. Construction of a genuinely thought-provoking essay question, testing certain higher abilities like application and imagination, and worded with care and precision, is a time-consuming job.

To reduce subjectivity in assessment, great care should be taken while framing the question, and the scheme of marking should be carefully prepared and scrupulously followed. Again, a good mixture of long-answer and short-answer questions in a question paper would help cover a representative sample of course content.

B. Short-answer Question—This form is becoming more and more popular due to several reasons. Objectives such as knowledge, application, interpretation and comprehension can be tested very successfully with this form. The question can also be made highly thought-provoking. In our present system

of examination, questions such as 'Give scientific reasons', and 'What happens when.....?' are of the short answer type, and are capable of stimulating reasoned thinking

(ii) *The Objective Form of Question*

In this form of question, the answers are completely controlled and therefore, the assessment becomes objective and impersonal. That is the reason why these are known as objective type questions. Here the word 'Objective' is used in the sense of being 'not subjective' and 'impersonal', and does not imply that it has a 'specific objective or purpose'. A question based on a certain objective may be framed either in the essay form or in the objective form.

In an objective form of question, alternative answers are given, out of which the pupil has to indicate the correct answer by using given symbols. The answer can also be indicated by underlining it or encircling the number or letter which it bears. If the alternatives are two or three and if they are small ones, the correct answer may be shown by scoring out the wrong ones. Such a device, where the pupil has no choice to write even a single word, ensures objectivity in scoring.

Depending on the number of alternative answers, the objective type question can be further divided into sub-categories.

A. Two-alternative Questions

These questions are popularly known as true/false or yes/no questions. But in addition to these frequently used pairs, there may be other pairs such as increases/decreases, reflection/refraction, more than/less than, and so on. For example .

Score out the incorrect alternative in the following :

1. Pure water freezes to ice on a mountain at 0°C .
True/False.
2. The poles of a horse-shoe magnet are near the middle-of/the ends of the magnet.
3. The purpose of wearing eye-glasses is to produce a clear image on the pupil/retina.

The following precautions may be taken while constructing two-alternative questions :

1. Do not straight-away lift a sentence from the text-book and use it as it is or with a slight modification.
2. Do not use indefinite terms such as frequently, mostly etc.
3. Do not use "tell-tales" such as always, never, all now, every, etc.
4. Do not use double negative.
5. Do not use partially true or partially false statements.
6. Do not use composite statements where one part may be true while another may be false.
7. Do not make the correct statements consistently longer compared with the false ones.
8. Do not restrict choices to only true-false or yes-no types. Use other alternatives also as illustrated above.

As they provide a 50 per cent chance to hit upon the correct answer by guessing, the usability of this form of question is very much reduced. The score may be corrected for guessing by using some formula such as,

Corrected score = $R - W$.

where, R = Right answers.

W = Wrong answers.

Moreover, as these questions usually test isolated facts of knowledge, they do not hold much appraisal value in examination. The only advantage is that they are comparatively easier to form and score. It may, therefore, be suggested that this form may be used only as an incentive to the pupils for revising a portion already taught or for preparing for a new topic and not for deciding promotion, rank or pupil-achievement.

B. Three-alternative questions

The following examples illustrate this type .

Score out the incorrect alternatives .

1. To a sample of milk (density 1.2 gm/cc), an equal amount of water is added, the density of the mixture will be more than/less than/equal to 1 gm. per cc.
2. An iron bar becomes hot when placed in the sun. This is due to conduction/convection/radiation of heat.

Since this form of question also allows guessing to the extent of 33 per cent on an average, it is very different from the two-alternative type of question. It may, therefore, be conveniently used as an incentive. The correction formula to be applied in this case is :

Corrected score— $R - 0.5 W$

where, R = Right answers,

W = Wrong answers.

C. Multiple-choice Questions

This form is in a way, an extension of the two-or three-alternative type of question. Here the alternatives may be four or preferably five. The more the alternative responses given in a question, the less is the element of guessing.

The first part of the multiple choice question is usually known as a 'stem' which may be in the form of an interrogative sentence or an incomplete sentence, or of several sentences according to requirement. The stem supplies the data on the basis on which the correct answer is to be found.

The second part of the question consists of alternatives wherein one is the 'right response', while the rest are 'distractors' or 'mis-leads'.

Illustrations of multiple-choice questions will be found under the specimen test-items given previously under 'knowledge' and 'application' objectives. Test-framers have devised various sub-patterns under the multiple-choice form which are useful for various purposes. Even the matching and master-list forms may be said to be patterns of the multiple-choice form. The following is an illustration of one of the sub-patterns of this form.

Whent : relative density of a material is 2, then,

- (1) 10 c.c. of the material weighs 20 gms ;
- (2) It is twice as heavy as water ,
- (3) 125 lbs. of the material occupies 1 cubic foot of space.

Read the above statements carefully and tick-mark the most appropriate alternative out of the following :—

- () A. 1 and 2 are correct
() B. 1 and 3 are correct

- () C. 2 and 3 are correct
- () D. All of them are correct
- () E. All of them are incorrect.

It requires sustained practice to attain skill in constructing a good multiple-choice question. The following precautions may be taken into account while framing such questions.

1. Five alternatives are preferable in order to reduce the guessing level to about 20 per cent on an average.
2. The distractors should be made as plausible as possible. They should very much look like a correct answer, but still not be the right response.
3. The right response should not be made too long lest it should be guessed as the correct answer just because of its length.
4. No clue should be given to the right response by certain words or grammatical feasibility.
5. As much of an item as possible should be included in the stem in order to avoid repeated reading of the same phrase in alternatives.
6. Normally there should be one and only one correct answer. If, however, there are alternatives which are partially correct, pupils should be asked to indicate the most appropriate answer.
7. The alternatives should be as homogeneous as possible.
8. Every alternative, if it is to function effectively, should evoke careful thinking to decide either its rejection or acceptance.
9. The construction of distractors requires as much care and caution as of the right response.
10. There should not be any ambiguity either in the stem or in the alternatives.

This form has become very popular, wherever the objective type of question is used because of their various advantages. By appropriate adjustments of the alternatives in the question, its difficulty value as well as the power of discrimination can be controlled. Objectives like knowledge, application and interpretation can be tested in a precise manner by this form. It creates interest in pupils and provokes thinking. It is most suited to measure different levels of thinking. Scoring is also

quick and easy. Guessing can be corrected by using the following general formula :

$$\text{Corrected score} = R - \frac{W}{n-1}$$

where,

R=correct answers ;

W=incorrect answers ;

n =number of alternatives.

(4 or 5 as the
case may be)

D. Matching Questions

This is an economical form of including a number of multiple-choice items in the same question, with the same alternatives. There are usually two columns in this form, of which one serves to provide alternatives. The following is an illustration .

Select the statements from column B to match with the appropriate planet listed in column A, indicating the number of the statement in the space provided under A

Column A

- () Jupiter
- () Mars
- () Mercury
- () Pluto
- () Saturn

Column B

1. A planet that does not belong to our solar system
2. The nearest planet to the sun
3. A planet that cannot be seen from the earth with the naked eye.
4. The biggest planet in the solar system
5. A planet where life might be expected
6. A satellite to Uranus
7. The farthest planet in the solar system
8. A planet having a ring around it.

This form may be used for situations where certain pairs are to be matched such as substances and their properties or uses,

principles and phenomena, causes and effects, systems of an organism and their organs, organs and their functions. There can also be three columns questions, say, properties as well as uses to be matched with the corresponding substances.

The precautions necessary to be taken while framing matching form of questions are the same as those in the case of multiple choice questions. In addition, the following points may be borne in mind :

- (1) The alternatives in a column may be arranged alphabetically if there is no other logical order.
- (2) The alternatives should be homogeneous.
- (3) The number of alternatives from where the answers are chosen for matching should be more by at least three than that in the other column, so as to reduce the chance element
- (4) The items for matching should not be too many, being kept at say, four or five in one column and seven or eight in the other, so as to avoid too much of reading while matching each alternative.

E. Master-list Questions

This is also an economical way of asking a number of multiple-choice questions having the same set of alternatives which serve as a master-list, a number of statements of questions following it, each to serve as a stem. Different stems may have different right responses out of the same master-list. The following example will clarify the point.

Master-list

- A. Carbohydrates
- B. Fats
- C. Minerals
- D. Proteins
- E. Vitamins

For each of the statements given below, select the correct answer from the master-list given above. Indicate your answer by putting the appropriate letter in the space provided against each statement

- 1. They cause digestive organs and others to function effectively

- 2. They prevent certain diseases like rickets and scurvy.
- 3. They are contained in the largest proportion in wheat flour.
- 4. They are needed for building bones, teeth, blood and protoplasm.
- 5. They are mainly lacking in 'separated' milk
- 6. They are often available in water
- 7. They are partly digested by the saliva in the mouth
- 8. Cheese contains them in large proportion
- 9. They are available from leafy vegetables in addition to vitamins.
- 10. They are made assimilable by the gastric juice in the stomach.

Thus, change in the pattern of multiple-choice questions by giving a common master-key lends itself to economise space and covers at the same time a variety of material on a given topic. Some of the stems may call only for information, while others may require application

The precautions listed for the construction of multiple-choice as well as matching questions may also be borne in mind while framing the master-list form of questions

We have, so far, been discussing the various forms and sub-forms of a question. Suitability of form is no doubt a very important criterion of a good question. But mere change in the form, say from the essay to the objective or vice versa, will not substantially reform an examination. Along with the form, important criteria like making the question thought-provoking and gearing it to a definite objective should also be kept in view. This remark requires all the more emphasis as there is a wrong notion that examination reform means changing the form of a question from the essay to the objective.

5. Power of Discrimination and Difficulty Value :

These two are also very important criteria of a well-framed test item. Each question should sharply discriminate the pupil who has achieved a particular ability or knowledge from the one who has not. Again, each question may have an estimate difficulty level, so that while compiling a full test, say, of general achievement, we may have a wide range of questions from

the easiest to the most difficult, maintaining the average difficulty value somewhere about 50 percent. However, it requires follow-up studies of pupil-responses to the test-items, and elementary statistical analysis, the details about which may be obtained from any standard book on educational statistics. Some agencies like Training colleges, Extension Services Departments or Examination and Research Bureaus may help schools in processing their test-items from these points of view.

It will thus be seen that a hard and sustained effort is necessary to improve questions for improving examination. The setting of an examination paper should not, therefore, be considered as a task to be undertaken only at the eleventh hour. The teacher is at his best in respect of a particular topic when he is dealing with it in class. Only then can he produce the most satisfactory questions. Therefore, he should form a habit of producing test-material on a topic while he is teaching that topic.

To save time, a collection of good questions may be made from various other sources and publications also. A good pool of test-material in the hands of the teacher will not only help him in improving his testing, but improve his teaching also.

To base questions on various objectives and topics, a teacher has to search for suitable test-situations. So far as General Science is concerned, the test-situations should be from the every day life of the pupils. The following suggestions for finding out a variety of test-situations may be helpful in framing good questions :

Test-Situations :

1. The home itself provides a variety of learning as well as testing situations. Kitchen, cookery, the building, ventilation, sanitation, water supply and disposal, electrical fitting and electrical appliances, are some of the aspects of the home which provide innumerable scientific situations.
2. Similarly, science in the street, in the *bazaar*, etc. may supply various situations.
3. Modern means of conveyance and tele-communication give scope for variety and novelty in test-situations.
4. Local industries, agriculture, factories, etc. may also be tapped for such situations.

- 5 The newspaper supplies many real situations such as news about accidents due to electrocution, food poisoning, heart failure, weather forecasts, weather charts, advertisements of patent medicines, tooth paste, tooth brush, machineries and their spare parts, etc
6. Scientific articles that appear in magazines and newspapers Relevant excerpts may be selected, and a series of questions may be set on them.
7. Description about modern discoveries and inventions.
8. *Excerpts from scientific books.*
- 9 Lives and works of great scientists
10. Toys modelled on scientific principles
11. Clothing and washing—synthetic fibres
12. Various charts, graphs, tables, etc. that pertain to health and hygiene, production, spread of diseases, climatic conditions, etc.
- 13 Other school subjects like Geography, Drawing and Art, Music, Crafts, Physical Education, etc
- 14 Various beliefs, customs, traditions, festivals and ceremonies.
15. Stories, proverbs and sayings that involve science.

The teacher may first relate such situations with teaching and then construct test-items on familiar as well as novel situations For evaluating the pupil's abilities to apply knowledge, interpretation and judgement, such a variety of situations would be very helpful. They also help to realize the concept of General Science, and to widen the pupil's horizon of applied scientific knowledge.

CHAPTER V—PLANNING FOR A FULL TEST

Criteria of a good test

A good test meets the following criteria :

- (1) Validity
- (2) Objectivity
- (3) Reliability
- (4) Usability.

Validity refers to the attainment of the purpose for which the test is prepared. A valid test measures the attainment of predetermined objectives for which it is designed, with reference to the subject content.

Objectivity refers to the precision of marking the answers. An objective test yields the same or nearly the same score, irrespective of the person who scores it.

Reliability refers, to the consistency in marking. A reliable test always gives the same or nearly the same score when scored at different times. The reliability of a test, in addition to other factors, depends upon (i) the length of a test (a longer test is more reliable), (ii) objectivity of scoring, and (iii) clarity of instructions.

Usability refers among others, to how well the test lends itself to administration, scoring and to the summarization of results.

Planning a test

A good test requires much careful planning. A mere collection of questions whatever their number and individual quality, does not make a full test. The main considerations to be borne in mind while planning a test are :

- (1) the coverage of behaviours implied by predetermined objectives ;
- (2) the coverage of syllabus ;

- (3) the grouping and arrangement of items of various forms ;
- (4) the number of items to be included in the test ,
- (5) the range of item difficulty.

(1) Coverage of behaviours implied by pre-determined objectives—

The first and the most important consideration in planning a test is to determine and clarify the objectives to be measured by it, in terms of pupil behaviours or abilities and also in terms of curriculum elements such as scientific principles, facts, terms, procedures, laws and skills. It is also necessary to determine the relative importance in the form of weightage to be given to each of the objectives.

(2) Coverage of syllabus

The second consideration in planning a test is to see how best the course content dealt with in the class can be covered. Proper coverage of the syllabus is important, because it is through the medium of the syllabus that objectives are achieved. An adequate number of items proportionately distributed over the syllabus will ensure a satisfactory coverage.

(3) Grouping arrangement of items of various forms

These forms of questions or items are possible, the objective type, the short answer type, and the essay type.

Objective type items may be (i) alternate response (true/false, yes/no, right/wrong), (ii) completion, (iii) multiple choice, (iv) matching, and (v) master list.

Since questions having clearly defined objectives can be constructed in all these forms, it is necessary in planning a test to decide how the positions in the different form can be grouped.

The criteria to be observed in grouping items are given below—

- (i) Items must be arranged in the order in which they are to appear in the test,
- (ii) Items of the same form or kind should be grouped together. This means that objective type, short answer type and essay type questions should be grouped separately. Further, items of the same kind

such as alternate response, multiple choice, matching etc should be kept together for the simple reason that each kind requires a different set of directions for the student. In other words items with common directions should be in one group.

(iii) Items should be arranged in increasing order of difficulty.

(iv) Items dealing with similar content should be grouped together to give the student a sense of test unity.

(4) Number of items to be included in a test

The number depends upon the duration of the test and the form of the items. An objective type test should not normally be of more than two hours duration. It is also obvious that the essay type of question will require more time than an item in either of the other two forms.

(5) Range of item difficulty

Item difficulty is concerned with finding how difficult an item is. The difficulty of an item is determined by the percentage of students passing it. In planning a general achievement test the range of difficulty should be as wide as possible and the items should be arranged in increasing order of difficulty. While items having 90 to 70 per cent difficulty may be easy, most of the items (70 to 30 per cent difficulty) should be moderately difficult, with a few items (20 to 30 percent) being of a very difficult standard.

THE TWO-DIMENSIONAL CHART

(A Blue Print)

Since a clearly formulated objective has two dimensions, namely the behavioural aspect and the content aspect, a test consisting of objective-based items should necessarily have two dimensions—coverage of behaviours implied by objectives and coverage of syllabus.

To ensure proper coverage, it is necessary to employ a graphical two-dimensional chart which would bring out the objectives or behaviours on the one hand and the content from the syllabus on the other. In the two dimensional chart given on pages 47-48, units I and II of the General Science syllabus contained in the Draft Syllabus for Higher Secondary Schools published by the All India Council for Secondary Education

(1957), are taken as an illustration. The outline of the units is represented in the first vertical axis and the behaviours implied by the two objectives—(knowledge and application of knowledge)—are shown along the horizontal axis. The chart is filled in the following manner

- (i) Decide first the total number of items to be included in the test (say 100), the weightage to be given to different units of the syllabus (40 per cent to unit I and 60 percent to unit II), and the weightage to be given to different behaviours or objectives (knowledge 75 percent and application 25 per cent equal weightage to behaviours under each objective)
- (ii) Distribute the number of items (100) in the proportion of the weightages as decided under (i). 75 items fall under knowledge and 25 under application. The 75 items are divided equally among the five behaviours. Out of the 15 items coming under each behaviour of knowledge, 6 are on unit I and 9 on unit II. Distribution of 6 items (unit I) and 9 items (unit II) is shown in the first column. Distribution of items in other columns is made in a similar manner. 25 items under application objective are also distributed in the same way.
- (iii) Enter the number of items in each cell of the chart as per distribution worked out in (ii.)

The chart now shows the distribution of items content-wise and behaviour-wise, and ensures proportionate coverage as per plan. Every item entered in the cells has two dimensions. The chart, so filled in becomes a blue print which serves as a frame of reference for constructing a test.

ADMINISTRATION OF A TEST

After selecting the items as per the two-dimensional chart, they must be arranged in the order in which they are to appear in the test. The following points regarding administration of a test deserve consideration :

- (a) As already explained, a test can consist of three groups of items according to the three forms—the objective, the short answer and the essay type. From the point

TWO-DIMENSIONAL CHART OF A TEST

BEHAVIOURAL ASPECT					
Objectives .	Objective No 1—To acquire knowledge of scientific facts, processes etc useful in every day life of a common man (75 per cent weightage)				
Content	Student recognises scientific terms, principles and facts	Student explains cause-effect relationship.	Student generalises into broad categories	Student knows sequence of a process	Student tests the adequacy of data
	1	2	3	4	5
Weightage	15%	15%	15%	15%	15%
Unit I—Our Surroundings	(6)	(6)	(6)	(6)	(6)
(a) The earth, rocks and soil	2	1	2	2	1
(b) Plants	2	2	2	1	1
(c) Animals	1	1	1	1	2
(d) The universe around us	1	2	1	2	2
Unit II—Nature of things	(9)	(9)	(9)	(9)	(9)
(a) Air	2	3	2	2	2
(b) Water	2	2	2	3	2
(c) Physical and chemical changes	3	2	3	2	3
(d) Metals of common use	1	1	1	1	2
(e) Common things we use	1	1	1	1	..
Total	15	15	15	15	15

IN GENERAL SCIENCE (UNITS I AND II)

OF THE TEST

Objective No 2—To apply scientific knowledge to
every day life situations of a common man.
(25 per cent weightage)

Student identifies a principle and relates it with data	Student suggests new devices instruments etc.	Student predicts hypothesis and checks it	Student formulates a hypothesis and checks it	Student detects a defect	Weightage.	Number of items
1	2	3	4	5	6	7
5%	5%	5%	5%	5 %		..
(2)	(2)	(2)	(2)	(2)	40%	40
.		1	1	1	.	10
1	1	.		1	.	10
1		1	1	.		10
.	1					10
(3)	(3)	(3)	(3)	(3)	60%	60
1	..	..	1	2	.	12
1	1	1	..	1	...	12
1	1	..	1	...	...	12
...	1	1	...		..	12
...	..	1	1	...	..	12
5	5	5	5	5	100%	100

of view of administration of a test, group I should form part I of the test while groups II and III together form part II of the test. However, if items in group II are very short, they may be clubbed with group I to form Part I.

- (b) Part I and Part II of the test should not be administered simultaneously, Part I generally preceding Part II.
- (c) Seating arrangements of pupils at the time of administering Part I should, as far as possible, be different from what is adopted while administering Part II.
- (d) The time to be allotted to Part I should be just sufficient to enable the average-pupil to complete it. This would perhaps minimise the malpractice that is likely to be associated during the administration of Part I.
- (e) For smooth administration of a test clear instructions should be given to students regarding (i) the credit to be given to questions, (ii) how to record answers and (iii) the scoring procedure to be used. A sample question with correct answer entered at the proper place should be given as a model.

SCORING

Scoring of the objective type test

One mark is usually allotted for every correct answer which may take the form of either a tick mark or a word filled in or a statement completed.

Items of the alternate response type are often subject to guess work. A multiple choice type item having 4 or 5 choices is less subject to this defect. A correction formula may be applied to reduce the effect of this defect.

Ways of marking or scoring

Four types of scoring are adopted, viz.

- (i) *Percentage marking*—Marks are awarded out of 100.
- (ii) *Letter-grading*—Student's answers are placed in the respective grades of A, B, C, D, etc.
- (iii) *Word description*—Remarks such as satisfactory, very good, ordinary etc. are given to answers.
- (iv) *Point award*—Points from 0 to 4, are sometimes allotted to answers.

Grade conversion table,

The following table indicates how one scores may be converted into another.

Points	0	1	2	3	4
Word description	Unsatisfactory	Below average	Average	Above average	Outstanding
Percentage	0—20	20—40	40—70	70—90	90—100
Letter	F	D	C	B	A

Averaging letter grade

This is done in three steps :

- (1) Numerical point values are substituted for letters i.e. A=4, B=3, C=etc.
- (2) Calculating the average of the numerical values.
- (3) Relocating the nearest corresponding letter-value.

Example—A student gets the following 8 letter-grades for 8 essay type questions he attempted : A A B C B F D A.

What is the average letter grading ? The student gets 3A, 2B, 1C, 1D, 1F. (Consult the table).

Step I A=4, B=3, C=2, D=1, F=0

Step II 3A=12
 2B=6
 1C=2
 1D=1
 1F=0

Total=21

Hence the average=2.6 (approximately).

Step III

Consult the table. Average letter-grading is B.

NOTE (1)—The range of percentage marks corresponding to letter grades has been fixed arbitrarily and is only indicative.

- (2) For consulting the conversion table, the percentage scores should be used without applying the correction formula.

SUMMARISING AND EVALUATING

Results are summarized for evaluating

- (i) the extent of attainment of the objectives (attainment score).
- (ii) the pupils' progress (the strengths and weaknesses).
- (iii) the teachers' work (methods of teaching).
- (iv) the curriculum (load and maturity level).
- (v) the items in the test.

Summarizing the results

After valuing the answer papers of students and before returning the papers to them, the teacher-examiner summarizes the results of the responses. This summarization is with reference to the two-dimensional chart already prepared. Let us suppose for example, that we want to find the extent of attainment of five pupils in one objective (knowledge) in relation to unit I and unit II of the General Science syllabus. We have already fixed the weightage to the two units as 40 per cent and 60 per cent. Since we have 100 items in our test as distributed in the blue-print chart, maximum scores for unit I and unit II will therefore be 40 and 60, on the supposition that one item has one mark. Collect the marks under knowledge items (75% weightage) with reference to the two units separately in respect of the five pupils, combine and enter them in the cells of the following table :

Pupils		1	2	3	4	5
Unit I	Max. Marks 30	11	7	7	23	6
Unit II	Max. Marks 45	30	23	30	33	7

The table shows that scores on unit II are in general comparatively higher than those in unit I. Several inferences can be drawn from this evidence.

- (1) The attainment of knowledge in relation to unit II is comparatively higher ;
- (2) Learning experiences in relation to unit II are better developed, method of teaching being superior ;

- (3) Pupil (5) is weak in both units and requires remedial teaching. Pupil (3) is weak in unit I and strong in unit II and requires particular attention for further diagnosis.
- (4) Unit II suits the maturity level of pupils better than unit I.

Similar tables can also be prepared in respect of

- (i) objective-wise performance ;
- (ii) unit-wise performance ,
- (iii) over-all performance of the entire class and even of the school ;
- (iv) behaviour-wise performance ,
- (v) individual performance

The two most popular methods that are being used by the teacher to summarize results are (i) finding the class average and comparing the individual's performance with it, and (ii) finding out the percentage of pupils who pass. The knowledge of pass percentage may help the teacher to plan out his work in such a way that more and more backward pupils reach the passing score. In other words the teacher adopts remedial measures to the weak pupils so that their performance may be improved. On the other hand, the knowledge about the average score of the class directs the teacher to help not only the weak ones but also the brighter pupils, as the performance of both types of pupils tends to increase the class average.

Summarizing for item-analysis

Summarizing the responses of students to separate items and reviewing each of the items in the light of these responses, provide a basis for item analysis and for preparing better tests in future.

To analyze the test results, first arrange the papers in the order of the total score, from highest score to the lowest. Then take the papers of one-third of students who got the highest scores and one-third of students who got the lowest, and tabulate for each item how each of the students scored in the answer. From this type of tabulation, the teacher can judge the nature of each item on the following points :

- (i) *Discriminating value*—Does it discriminate the bright from the poor students?

(ii) *Ambiguity*—Has the item doubtful discriminating value ?

(iii) *Difficulty*—How difficult is the item ?

Thus it is seen that summarizing the results with reference to (i) the two-dimensional chart and (ii) item analysis, provides valuable data for interpretation and evaluation.

On the basis of the data summarized in various ways, the teacher-examiner can find out whether a particular objective is quite appropriate to the maturity level of the pupils, to the needs of the society and so forth. He can also draw inferences about the suitability or otherwise of various topics under a given syllabus. The effectiveness of teaching devices that he employed and that of the learning experiences he provided can also be judged. In short, the evaluation of various facts of science education such as objectives, syllabus, text-books and learning experiences would enlighten him in modifying the curriculum and his programme of teaching and thereby making the system of science education dynamic and growing.

CHAPTER VI—FURTHER SUGGESTIONS TO TEACHERS

While the previous chapters have suggested various ways of improving the quality of teaching and evaluating, a few more suggestions for the implementation of the evaluation approach in daily practice are given below

1. This approach aspires to bring dynamism into educational practice, and therefore it should be followed in spirit rather than in letter. Conviction in the approach is necessary, hence it is suggested that the approach may be tried out once or twice with an experimental attitude.
2. Once insight is gained into the whole procedure, the teacher may formulate a set of specific objectives of teaching General Science, and clarify them in terms of expected behaviour changes at the beginning of the academic year.
3. He may then prepare a two-dimensional chart having a list of objectives on the vertical axis and units of course-content on the upper horizontal axis: With reference to the nature of the unit, he selects a cluster of objectives as targets of achievement.
4. He should make the first evaluation of his plan as to whether the plan is attainable, whether it can be finished during the time available, whether all the objectives are well represented in the chart, etc.
5. The next stage will be to develop a unit-wise plan of teaching. Based on a particular unit, a variety of learning experiences may be developed and organised in complete relevance with the objectives selected for attainment through that unit. Detailed plans may be made in advance about teaching devices to be adopted for effectively providing learning experiences, equipment necessary for that, etc. The plans may be improved and enriched year after year.

6. Achievement of pupils should be evaluated immediately after completing the unit. Based on the nature of the objectives, various methods of collecting evidence about pupil-achievement may be adopted such as written, oral, practical, observational or any other method of assessment
7. The results of the examination may then be summarized, and the extent of achievement of various objectives may be measured, based on which inferences may be drawn for effecting modification in future teaching.
8. The procedure may then be repeated with another unit after modifying its plan of teaching in the light of previous experience.
9. Comprehensive examinations may also be held twice or thrice in a year to assess the over-all development of pupils in terms of predetermined objectives.
10. Various life-situation in General Science may be collected from different sources and used in teaching as well in evaluating.
11. A rich collection of good test-items should be maintained by the teacher. Various sources may be tapped for the purpose, so that at the time of the examination he has a wide variety of material for editing a full test.
12. Qualitative evaluation should take place at every stage of the programme, each stage being a continuous process to improve the one succeeding it. Thus, enriched learning experiences and evaluation material related to the objectives of teaching General Science, when used by the teacher in his class room practice, are bound to raise the professional competence of teachers and standard of achievement of pupils.

APPENDIX

EVALUATION TEST ITEMS

Objective Type

I. Objective—To acquire knowledge of “Weather” useful in the life of the common man

Behaviour—The student recognises scientific terms and processes connected with “Weather”.

Place a tick mark in the space provided against the word that best completes the statement.

(1) Small drops of water that remain suspended in the air near the surface of the earth are called

- _____ (a) fog
- _____ (b) clouds
- _____ (c) dew
- _____ (d) frost.

(2) When dew-point of air is below 0°C , water-vapour in clouds may form

- _____ (a) rain
- _____ (b) snow
- _____ (c) frost
- _____ (d) hail.

(3) In each answer space, write the letter of the item from column B which best matches the items in column A.

<i>Column A</i>	<i>Column B</i>
_____ 1. Cooling effect	(a) cloud
_____ 2. Clouds are treated with dry ice to make rain or snow	(b) condensation
_____ 3. Gases change to liquids	(c) evaporation
_____ 4. Amount of water vapour in the air.	(d) humidity
	(e) precipitation
	(f) seeding.

Behaviour—Student explains cause-effect relationship.

Place a tick mark in the space provided against the word or phrase that best completes the statement.

(4) The earth remains warm after sunset because of

- _____ (a) the oceans

- (b) the mountains
- (c) the moonlight
- (d) the atmosphere

(5) Winds are caused by the movement of air from

- (a) low to high pressure region
- (b) north to south
- (c) high to low pressure region
- (d) warm to cool region

Behaviour—The student generalizes data into broad categories.

(6) The following statements describe some stages in the phenomenon of condensation of water. They are to be classified into broad categories. Put the letter D in the space provided, if the statements are directly connected with the formation of dew. Put the letter F in the space provided, if the statements are directly connected with the formation of fog. 'C' if directly connected with cloud, and 'R' if directly connected with rain.

There might be other statements not directly connected with any of the above stages. Put 'N' in such cases in the space provided.

- (a) The invisible water vapour in the air condenses on particles to form extremely small visible droplets, which remain suspended in air near the surface of the earth.
- (b) Rising air containing sufficient water vapour is cooled below its dew point, while there are particles in the air around which tiny droplets of water or crystals of ice or snow can collect.
- (c) At night objects on ground and the ground itself often becomes cooler than the surrounding air so that the water vapour in the air surrounding the objects condense.
- (d) When tiny droplets of water combine, they become too heavy to remain suspended in air.
- (e) When dew point of air is below 0°C , water vapour in air may change directly from a gas into solid ice crystals.

- (f) Large drops of water are carried from a lower to a higher part of a cloud that extends to very high levels where temperatures are below 0°C

Behaviour—The student observes and draws inferences.

- (7) In each of the following, write 'T' if the statement is true, if false, underline the incorrect word or phrase and place the correction in the space provided.
- (a) Evaporation and condensation are two steps in water cycle
 - (b) The North and South Poles receive direct rays of the sun.
 - (c) Cool summers and mild winters are found along sea coasts.
 - (d) Fog and clouds are formed when warm and moist air hits colder air.
 - (e) A sea-breeze blows because the air over the land is colder
 - (f) The average air pressure at sea-level is 14.7 pounds per square inch
 - (g) Air has pressure because it has weight
 - (h) The heaviest dew forms on cloudy nights

Behaviour—The student recognizes sequence of scientific process.

(8) The following statements describe the various steps in the phenomenon of condensation of water (water cycle in nature). The statements are not in the sequence in which condensation of water occurs. Put in the blank spaces, serial numbers 1, 2, 3, etc. to denote the order of occurrence in the phenomenon.

- (a) The air near the surface of the earth contains water vapour.
- (b) Droplets of water are formed in air containing dust and smoke.
- (c) A fall in temperature causes water vapour to condense.
- (d) Moisture is constantly evaporating from bodies of water and the moist surfaces of earth.

- (e) The air holds as much water vapour as it possibly can, at a certain temperature.

Behaviour—The student tests the adequacy of data.

- (9) For determining dew point, various sets of apparatus and material are supplied. Only one set is required. Select it and tick mark in the space provided.

- (a) Two thermometers, two polished metal cups containing water and ice.
- (b) Two thermometers, two polished metal cups containing water, one stirring rod.
- (c) Two thermometers, two polished metal cups containing water, ice, two stirring rods, two cardboard packing boxes.
- (d) A maximum and minimum thermometer, two metal cups containing water and ice, two stirring rods, two cardboard packing boxes.

II. Objective—To apply the scientific knowledge of 'weather' in the life of the common man

Behaviour—The student identifies the principle in a problem, and relates it with the data in the problem.

In the space provided, tick mark the word or phrase that best completes the statement.

- (10) On some very high mountains there is snow all the year round, because
- (a) heated air rises
- (b) air cools as it rises
- (c) clouds keep the snow from melting
- (d) cold air on the valleys keeps the mountains cold.
- (11) (a) What part of the day is the best time for the formation of clouds that produce thunderstorms ? Why ?
- (b) A thunderstorm is generally accompanied by lightning. Why ?

Behaviour—The student suggests new devices, new procedures and new instruments.

- (12) Out of the following experiments designed to prove that the heating of air produces changes in pressure, only one

experiment correctly proves it. Select it and place a tick mark in the space provided.

- _____ A. Drop a piece of burning Paper into a bottle and place a cardboard over the mouth of the bottle. Press the cardboard. What happens to the burning paper ? Why ?
- _____ B. Drop a piece of burning paper into a bottle. Place the palm of your hand over the mouth of the bottle the instant the flame goes out. Wait one minute and then raise your hand. What happens? Why ?
- _____ C. Insert a burning candle in a bottle containing water. Close the mouth of the bottle. What happens? Why ?
- _____ D. Insert a small piece of sodium in a bottle containing water. Close the mouth of the bottle. What happens? Why ?

Behaviour—The student predicts and checks his prediction.

- (13) The specific heat of five unknown substances are given below. We have to find out whether or not the substances warm and cool at the same rate. Write in the space provided 'X' against that substance which warms and cools most rapidly, and 'Y' against the substance which warms and cools most slowly.

	<i>Substance</i>	<i>Specific heat</i>
_____	A	0.34
_____	B	0.68
_____	C	0.18
_____	D	0.24
_____	E	0.74

Behaviour—The student formulates a hypothesis and checks it.

- (14) While determining dew-point, a pupil writes a number of statements. They are given below. Out of these statements, some are basic assumptions. Identify them and tick mark in the space provided.
- _____ A. The polished metal cup containing water and ice has the same temperature as the water in it.
- _____ B. The dew-point determined at one place is the same as that determined at any other place.

- C. The dew-point determined at two different times at the same place is the same.
- D. The air trapped in the polished metal cup is no different from the air outside.
- E. The temperature of water in the polished metal cup on which droplets of water appear is invariably less than that of water in the other polished cup.

Essay Type

1. To acquire knowledge of weather.

Behaviour—The student explains a scientific instrument

15. Explain with an illustrative diagram the working of

- (i) a mercury barometer and
- (ii) a wet and dry bulb thermometer.

- II. To apply the scientific knowledge of 'weather' in the life of a common man.

Behaviour—The student explains cause-effect relationship.

16. Give scientific reasons for the following:—

- (i) No dew is formed when the night is cloudy.
- (ii) Temperature of a room lowers when water is sprinkled on its floor.
- (iii) In winter the whistle of a train is heard more clearly
- (iv) In summer we should not use black clothes.

BIBLIOGRAPHY

General Science

1. BARNARD, J. D. and LON EDWARDS *The New Basic Science*. New York : Macmillan and Co., 1956
2. BEDUCHAMP, W. L., & OTHERS. *Science Problems Parts 1 & 2*, Chicago . Scott, Foresman and Company, 1951, 1952
3. BLACKWOOD, PAUL E. *Experiences in Science*, 2nd. Edition, New York : Harcourt Brace & Company, 1957
4. BRANDWEIN, P. F. & OTHERS *You and Science*, New York . Harcourt Brace and Company, 1955
5. CURTIS, F D & G G. MALLINSON. *Science in Daily Life*, New York . Ginn & Co., 1955
- 6 ELEY, G. S. & OTHERS. *The Physical Sciences*, New York . Ginn & Co., 1954

The Teaching of General Science

7. NEISS & OTHERS. *Modern Science Teaching*, New York . Macmillan & Co., 1955
8. SAUNDERS, H. N. *Teaching of General Science in Tropical Secondary Schools*, London : Oxford University Press, 1954
9. TYLER, RALPH W. *Basic Principles of Curriculum and Instruction*, Chicago : The University of Chicago Press, 1957

10. UNESCO. ~~INSTITUTE FOR THE IMPROVEMENT OF TEACHING~~ *Unesco Source Book for Science Teaching*,
Paris : Unesco, 1957

Evaluation

11. ALL INDIA COUNCIL FOR SECONDARY EDUCATION. *Evaluation in Secondary Schools, Revised Edition*, New Delhi, D. E. P. S. E., 3/17, Asaf Ali Road. 1960
12. BLOOM, B S *A Taxonomy of Educational Objectives*,
New York : Longmans Green and Co., 1956
13. FURST, E. J. *Constructing Evaluation Instruments*,
New York : Longmans Green and Co., 1958
14. GURBERICH, J. REYMOND *Specimen Objective Test Items*, New York . Longmans Green and Co., 1956
15. ROSS, CLAY C *Measurement in Today's Schools*, Revised by Jullian C. Stanley, New York : Harpar and Bros. 1954
16. TRAVERS, ROBERT M. W. *How to make Achievement Tests*, New York Odyssey Press, 1950
-

